Surgery – Dr. Amanj – Lecture 1 – Cardiac Surgery Principles

Why cardiac surgery is more difficult?
Moving organ
Contains blood
Vital, and no place for mistakes.
Shared with anesthetist
Very sensitive to electrolyte derangements

Approaches for cardiac surgery:
The main and the commonest incision for the cardiac surgery is median sternotomy.
But others could be used like:
Right anteriolateral thoracotomy
Left posteriolateral thoracotomy
Minimally invasives.
Endoscopic approaches.
Clamshell incision.

Cardio pulmonary bypass (CPB)
Basic principle of CPB is:
Bypass the right and left side of heart
Thermal regulation
Oxygenation
Filtration

So the use of CPB:
Cardiac surgery; bloodless field for the surgeon.
Veno-venous bypass like in liver surgery.
In treatment of hypothermia
In period of asystole
As assisted device for the ventricule. (VAD)
For oxygenation, ECMO

Rationale for the use of CPB
During open heart surgery, CPB provides the surgeon with a clear field for cardiac manipulation and maintenance of pulmonary and hemodynamic stability. The objective of heart-lung pump is to provide enough flow to maintain a sufficient cardiac index for tissue perfusion.
The addition of cardioplegia allows the surgeon to work in a motionless and bloodless field.
The addition of hypothermia to CPB has been standard practice since Bigelow demonstrated improved tolerance of the entire organism to ischemia accompanied by hypothermia.
The CPB Circuit

Venous conduit → Drains blood from venous systemic circulation. Usually a cannula for blood drainage inserted into the right atrium with openings for IVC and SVC.

Arterial blood return → Returns oxygenated blood back to the body via arterial cannula most often placed in the ascending aorta.

In the middle → Pump/Oxygenator is run by the perfusionist. Provides oxygenation and means of delivering various elements to patient during CPB. Then pumps blood back to the arterial circulation.

Sites of arterial canulation

Ascending aorta

Arch of aorta.

Right subclavian.

Femoral artery.

Some times SVC used to perfuse the brain. (Dearing)

Components of CPB circuit:

- Venous drainage; (bicaval or two staged in RA
- Reservoir
- Pumps
- Pump prime (the fluid), made of balance salt solution, colloids, mannitol, bicarb, heparin.
- Oxygenators; (Bubble or membrane)
- Heat exchanger
- Arterial inflow
- Cardiotomy suction
- Ventricular venting
- Filters

**Steps of cardiac surgery with the use of CPB, (simplified)**

- Heparinize.
- Insert canulae
- Connect to lines already prepared.
- Go on bypass.
- Demand for the required temperature
- Cross clamp the aorta
- Give cardioplegia
- Do the procedure
- No more plegia
- Re-warm
- Stop CPB.
- Remove the cross clamp
- Remove the canulae

**Monitoring during CPB**

This will be done by the coordination between perfusionist and anesthetist

Includes monitoring of:
- Perfusion pressure
- Venous return
- Urine output
- Temperature
- Blood gas
- Electrolytes
- ACT, (Clotting time)
- PCV
- PO2 and PCO2
- ECG activities if any
- Time for the plegia
- TEE and presence of air in the heart.
- EEG in some cases of circulatory arrest.

Need for medications

**Hypothermia principle**
Generally during bypass for the cardiac surgery there will be alteration in the blood pressure and decreased tissue perfusion, to overcome this problem body temperature is lowered to decrease the metabolism and to prevent hypoxic tissue damages. Most important tissues need to be protected are the brain and the heart.

This is explained and applied through the rule of Q10

Meaning: by decreasing the temperature of the body by 10 C, lead to the decrement of metabolic rate by 50%

**Techniques of hypothermia:**

HLFB: hypothermic low flow bypass.

DHCA: deep hypothermic circulatory arrest.

**An important variant of CPB**

**Total Circulatory Arrest**

- Used during repairs of great vessels and certain congenital heart lesions.
- Involves complete temporary cessation of perfusion
- Vital to ensure profound hypothermia (15 C) as well as decreased cerebral oxygen metabolism.
- Corticosteroids, Mannitol, Thiopental, Phentolamine to speed cooling?
- Complete EEG silence/ Burst suppression

**Cardioplegia**

It’s a solution of dextrose and potassium.

The elevated levels of extracellular potassium increase the transmembrane potassium gradient. This inhibits cellular repolarization of myocardial muscle cells thus preventing myocardial muscle contraction.

Another type: is blood CP.

**A Little Cardiac Physiology**

Cardioplegia inhibits myocardial muscle contractility.

However this will normally be reversed over time (15-20min) by unique ability of cardiac muscle to utilize anaerobic pathways to produce high energy phosphates for muscle contraction.

As a result cardioplegic solution must be administered periodically to prevent cardiac contractions.

**Route of giving CP**

Antegrade.

Retrograde.

Direct ostial.